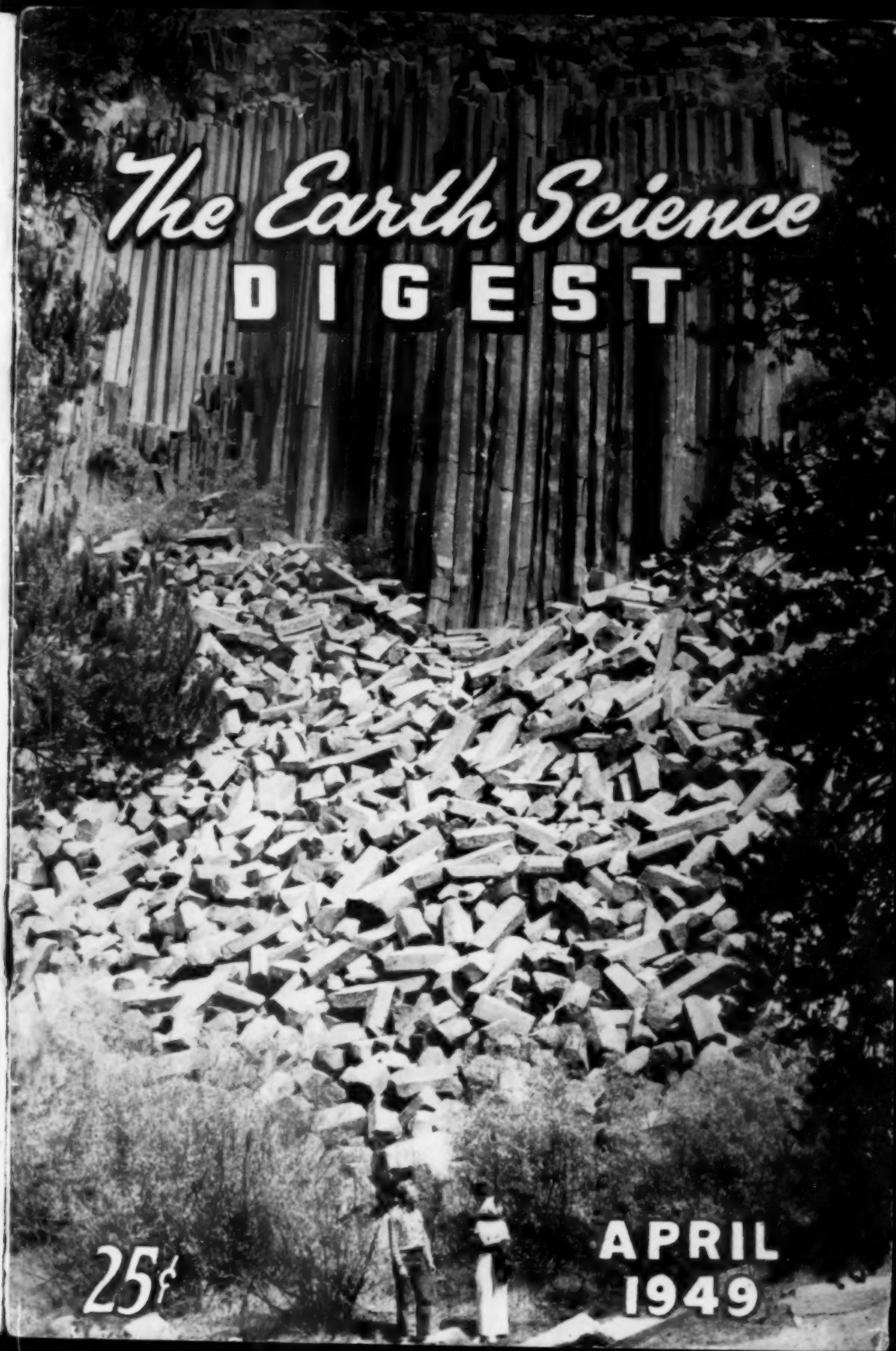
The Earth Science
DIGEST
25¢
APRIL
1949

The Earth Science Digest

Revere, Massachusetts

Vol. III APRIL - 1949 No. 9

A magazine devoted to the geological sciences.

THE EARTH SCIENCE DIGEST is open to articles of geologic interest. Manuscripts, photographs and sketches will be returned if accompanied by ample first-class postage.

Subscriptions: U. S. and possessions, Canada, Philippine Is., Latin America, and Spain: 1 year, $2.00; 2 years, $3.75; 3 years, $5.00. Other countries: 1 year, $2.50. Single copies, 25 cents.

Special group subscription rates allowed to educational institutions and societies.

Published monthly by The Earth Science Publishing Company, 77 Victoria Street, Revere, Mass. Entered as second class matter April 12, 1948 at the post office at Boston, Massachusetts, under the Act of March 3, 1879.

S. Albert Eisenberg, Publisher
Gertrude Roberts, Business Manager

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ASSOCIATION OF GEOLOGY TEACHERS MEETS IN CHICAGO APRIL 22-23

The ninth annual meeting of the Association of Geology Teachers will be held April 22–23 at Rosenwald Hall, the University of Chicago. The program for April 22 will include inspection of the Geology Department at the University of Chicago, a business session, and presentation of papers on geologic education. Field excursions and committee meetings will be held on the 23rd.

Non-members wishing to attend should communicate with the Secretary: Miss Katherine F. Greacen, Dept. of Geology, Milwaukee-Downer College, Milwaukee, Wisc.

THE DEVIL POSTPILE (COVER PHOTO)

The Devil Postpile National Monument, located in California on the east side of the Sierra Neveda, is the remnant of a lava flow which originated in Mammoth Pass probably between 100,000 and 200,000 years ago, during the last interglacial epoch in the Sierra Nevada. The columnar basalt was readily weathered away by the last readvancement of the Middle Fork Glacier, and only the more obdurate parts remained. The largest of these was the Devil Postpile, which is about 900 feet long and 200 feet in height. On one side of the Postpile a sheer wall of columns 40 to 60 feet in height is exposed. Photo by Ralph H. Anderson, courtesy of the National Park Service.

Surface Geology at the Border of an Ice Sheet

C. W. WOLFE
Boston University

Much attention has been directed in recent years to the peculiar phenomena which develop in an area where a large glacial mass is in close proximity. The depiction of *periglacial* activity has been largely through the efforts of many students who have been inspired by Professor Kirk Bryan, Harvard geomorphologist. Many surface characteristics in north temperate regions proved unexplainable until the reality of the prodigious influence of large ice sheets on surface phenomena was realized. Study extends now from Tundra areas southward to areas which were never occupied but which were bordered by the ice sheets of the Pleistocene epoch, and an elaborate terminology has been constructed. The general principles and discoveries are relatively simple and are discussed here in order that the amateur geologist in glaciated and subglaciated regions may gain more from his excursions into the field.

Periglacial Frost Action

Weathering, which is usually termed *periglacial weathering,* is unusually rapid and intense in glacial areas, and frost action is the principal agent of this weathering. The disruptive force of freezing water is well known by its effect on water mains and baked clods of clay, the latter having been formed by plowing of wet ground and subsequent sun baking of the clay masses. These clods resist wind, rain, and soil cultivation throughout an entire season; but frost action in the succeeding winter and spring reduces the masses to soil once more. Near the periphery of a glacier during summer months the shift of temperature from day to night is of considerable magnitude and frequently crosses the freezing point. Thus, during the day, water forms in cracks in rocks of all sizes, and with the night freezing, with accompanying expansion of the cracks, takes place. This is followed the next day by thawing and sinking of water into the deepened crack.

Such extensive frost fracturing has many important results, one of the most important being the formation of what is known as *felsenmeer,* a rock sea. The most unique illustration of felsenmeer is that which develops on high, flat, barren mountain tops, particularly where the rock is massive — free from fractures. On the summit of Mt. Washington in New Hampshire, for example, great blocks of rock, many as large as a good sized room, may be observed on all sides. In fact, the solid bed rock appears nowhere. Only under conditions of extremely intense frost action could such frost quarrying take place, and it is imagined that this felsenmeer developed when the continental glacier stood within a few score of miles of the Mt. Washington area. It is not necessary that felsenmeer be so coarse; it may as readily be almost soil-like at the surface and extend to a depth of a few feet, with much coarser material in depth.

Another example of intense peri-

Photo by Gannett

Extensive frost action in the Sierra Nevada. The large talus slopes are similar to those produced by periglacial weathering.

glacial frost action may be seen in the tremendous *talus slopes* of rocks. The edges of the blocks show practically no sign of chemical weathering. Modern frost action is not sufficiently rapid to produce large scale frost quarrying on cliff faces without at least some signs of accompanying chemical weathering. In many cases the talus slopes have been covered by a thin layer of soil, and trees may almost completely mask their existence, proving that they were formed in an earlier period when frost action was far more extensive than at present. The phenomenon is most readily observed and preserved where the rocks involved are very resistant to chemical weathering; quartzite, in particular, is best suited to preserving the record of the former extent of periglacial frost action.

Frost Heaving

Whereas frost quarrying is best exposed in regions where bare rock is exposed, another expression of frost action is developed in regions where a soil cover, either of residual soil, or of till, or of previously formed felsenmeer, exists. In these places *frost heave* takes place, and peculiar subsurface and surface features develop. It is too little realized that frost frequently is concentrated into definite lenses beneath the surface in particularly favorable spots. This concentration produces the lifting or heaving of the surface which almost every motorist has experienced in early spring in north temperate regions. Another manifestation of frost heaving however, is the raising of "stone crops" in glacial till areas. Many a farmer has labored under the misconception that stones actually grew in his land, forcing him to the back breaking labor of building stone fences. Actually, of course, the raising of boulders toward and to the surface is the direct result of frost action which behaves differentially upon boulders and soil during both freezing and thawing. Boulders are raised, and soil slumps beneath them, making a return to the former position impossible. In a similar manner, fence posts are lifted appreciably in regions where frost action takes place today. Under conditions of periglacial frost action, heaving was far more extensive than at present, and this may well explain the erratic but extensive distribution of boulders, particularly resistant boulders, which is found in closed undrained areas from the Blue Hills of Boston to the Driftless area of Wisconsin to valley floors in the Rockies.

Solifluction

When frost develops in soil with sloping surfaces, the soil tends to migrate downhill with continued freezing and thawing. This movement of relatively solid masses is known as *solifluction*, and it is obvious that this process must have been far more intense during periglacial times than at present. Several manifestations of this soli-

Official U. S. Navy Photograph

Edge of Antarctica showing typical environment where periglacial weathering is proceeding today. Neny Island at extreme left, with two unnamed peaks at right, in the Marguerite Bay Area.

fluction develop, particularly in association with considerable frost heaving. The simplest example is that of a *rock ring*, which is a ring-like accumulation of pebbles around a common center. These rings may be due to slumping of surface materials away from a common center which is heaving; the pebbles slide or roll down the sides of the doming surface. The core of the rising sector may be either a large boulder which is gradually being lifted or a pocket of soil which tends to collect considerable quantities of water so that frost expansion is much greater in that region.

On relatively gentle slopes *stone nets* may develop. These are recognized by the net-like distribution of pebbles and boulders in an area with fine soil filling the openings in the nets. The latticed nature or polygonal appearance of the stone nets has been variously explained, one explanation being that they are the result of the coalescence of many rock rings. Their shapes, however, lead to another explanation. It is well known that wet soil upon drying, contracts and forms prism-like surface masses. The same phenomenon develops in wet soil which exists at subfreezing temperatures. Although water expands upon freezing, continued cooling of the ice is accompanied by a considerable contraction.

Cracks with widths of more than two inches are well known in northern lakes during the coldest portion of the winter. If soil is saturated with water and freezes, and if continued lowering of temperature takes place, polygonal cracks must develop in the soil. These cracks may fill with fine soil or with surface water, and continued development of the frost wedge may ensue. The complete details of the formation of the stone nets cannot be given here but are amply given in the references which are listed at the end of this paper.

Another surface feature which is associated with the development of stone nets but seems to form on somewhat steeper slopes is the *rock stripe*. In some areas stones are concentrated on the approximately even sloping surface into definite stream-like aggregations. The precise method of formation for these stripes is not known as yet, but they are undoubtedly associated with the combined activity of frost heave and solifluction.

Permafrost Areas

In the Tundra region of the Arctic the soil below a definite depth is perennially frozen. The surface soil thaws every summer, but thawing never proceeds sufficiently deeply before the advent of another winter causes freezing of the ground once more. There is developed, consequently, a surface condition throughout the summer which is comparable to conditions in the northern United States when the "frost is coming out of the ground" in the spring. Actually, water accumulates in the top soil throughout the winter by gradual capillary rise from the water table below and fills all of the pore spaces of the soil at the surface with ice. During the spring thaw, the surface frost melts while the underlying frost remains untouched, producing an impermeable barrier to the downward percolation of the trapped surface melt water. The impermeable barrier never disappears in the tundra area, and the resulting effects can readily be imagined.

If the permanent frost area or *permafrost horizon* is sloping, solifluction will proceed at an extreme rate, particularly if there is alternate freezing and thawing in the zone. Stratification or bedding in the soil may be highly disturbed by this movement, and *involutions* or apparent folding will result. Considerable quantities of dissolved mineral matter may precipitate at the permafrost horizon. The mineral substance may be either calcium carbonate or iron oxide. In either case a complete cementation of the layer develops, forming an extremely tough and inpenetrable *hard pan*. A very resistant hard pan of this type is well developed in the glacial drift in Wisconsin thirty miles east of St. Paul, Minn., in the Roberts-River Falls areas.

Lakes and sinks may develop in regions of permafrost due to differential melting of the frosted areas, since different soils have different heat conductivity. For more extensive material on this subject the reader is referred to the references given later.

Periglacial Wind Action

The air masses above a large ice cap are typically cold, heavy and descending. As a result, winds move constantly and with considerable force away from the ice sheet. Not until they have moved several hundred miles are their forces spent. We should expect, then, to find evidences of extensive wind action in favorable localities

Photo by Alden. Courtesy of U. S. Geological Survey.

Loess above glacial till. Contact is at hammer

which have been subjected to periglacial winds. In probably no area were conditions more advantageous for the production of aeolian phenomena than in the Roberts-River Falls area mentioned above.

This region was once covered by a continental ice sheet which left its usual record of till and fluvioglacial deposits. Upon the retreat of the ice weathering by oxidation proceeded at least to a depth of ten to twelve feet in the fluvioglacial material, indicating that the drift is much older than the last glaciation. The last ice stage or Wisconsin ice never advanced over the region but came sufficiently close to leave an unmistakable record.

In many places wind polished stones or *ventifacts* may be found lying on the surface of the ground. They vary in size from a fraction of an inch to more than two feet across. Well developed facets or faces may be seen on most of them. The peculiar luster of wind polish is well preserved on those rocks which are chemically resistant; these include the quartzite and granite which were brought into that sedimentary rock area by the preceding ice sheet. Some of the rocks are fluted, indicating that the rock surface over which the wind-blown sand moved was at a relatively low angle. Other ventifacts are pitted, indicating a steep slope against which the sand blasting took place.

As the glacier retreated, the effectiveness of the winds as erosive agents gradually diminished, and deposition became the rule. Thus there formed in favorable localities, particularly in basin areas and along streams, large quantities of wind-blown dust, called loess. Where these loess deposits are

U. S. Dept. of the Interior

Ventifacts. Sand blasted pieces of limestone found in Death Valley.

found, the soil is rich and fertile; but where they are lacking, the soil is impoverished and unsuitable to extensive cropping. Where sections have been cut through the loess and down into the underlying glacial drift, it is possible to see considerable quantities of ventifacts at the juncture between the loess and drift.

Thus, the field geologist, by imagining those conditions which must have accompanied periglacial climates, can reestablish those conditions and explain in a satisfactory way many surface features which otherwise would have no acceptable explanation.

Those interested in periglacial weathering should consult the March 1949 issue of the *Journal of Geology* (The University of Chicago Press, Chicago). This issue of the Journal is completely devoted to a consideration of periglacial phenomena, and an extended bibliography can be gathered therefrom. *Glacial Geology and the Pleistocene Epoch* by Richard F. Flint is an excellent specific treatment on many glacial phenomena.

'Eruptive Evolution' As Explanation of Diverse Cambrian Animal Life

The hypothesis that the amazing diversification of early Cambrian animals may have been in large part a matter of "eruptive evolution," most nearly comparable to the seemingly abrupt deployment of mammalian stocks in the Cenozoic era, is advanced by Dr. Preston E. Cloud, Jr., of Harvard's Museum of Comparative Zoology.

In a comprehensive review of evolution patterns exemplified by fossil invertebrates, presented in a recent issue of *Evolution* — international journal of organic evolution, Dr. Cloud discusses a problem which always has held the greatest interest for geologists who have observed the apparently sudden appearance of many groups of the lower animals in the early Cambrian rocks, just above the almost barren sediments deposited during the "dark ages" of the pre-Cambrian.

"Eruptive evolution" is defined as a relatively sudden breaking out of evolutionary diversification within any group of organisms. The inferred pattern and sequence, as stated by the author, are the relatively sudden appearance of marked variability, probable availability and proximity of a variety of life niches, and finally increased selective pressure, resulting in the weeding out of poorly adaptive stems and leading to a more regularly channeled evolutionary phase for the particular stock involved.

Dr. Cloud recalls the frequently voiced explanation that no well-authenticated types of animal life are known in the pre-Cambrian because the forms then living were without protective covering suited for preservation as fossils, and that animals first began to secrete shells at the beginning of the Cambrian.

The Earth Sciences — 1949

Tin Ore Discovered in Ontario

TORONTO, March 3—Ontario's first authentic discovery of tin ore was disclosed in a preliminary report released by Hon. Leslie M. Frost, Minister of Mines for Ontario.

The report, accompanied by detailed maps, refers to the discovery of cassiterite, by Stanley Johnson. The author, E. O. Chisholm, resident geologist of the Ontario Department of Mines at Kenora, spent two days in October, 1948, examining the discovery claims. Trenching which had been carried out was examined in detail and a brief reconnaissance made to the east and west of the main showing.

Many claims were staked in the Linklater Lake area as a result of the discovery. According to Chisholm, the tin deposit at Linklater Lake has many of the characteristics of other tin deposits in the world that appear near the contact of acidic granite rocks.

Chisholm suggests that careful prospecting along the whole zone of the granite-sediments contact and southwards to the greenstone is warranted. The report is available, free of charge, at Departmental headquarters at Queen's Park.

Radioactive Carbon Used As New Measure For Age

CHICAGO, March 6 (Science Service)—Radioactive carbon can be used in measuring the age of anything that has been alive within the past 20,000 to 25,000 years, it has been determined in experiments at the Institute for Nuclear Physics on the University of Chicago campus here. The work was done by a three-man research team consisting of Drs. W. F. Libby, E. C. Anderson and J. R. Arnold; they report their findings in the journal, *Science*.

There is a very small concentration of radioactive carbon, of atomic weight 14, in the air at all times. It is believed to be formed by the bombardment of nitrogen atoms by cosmic rays at high altitude. This radioactive carbon enters into the composition of organic compounds, and thus of living things, just like ordinary carbon of atomic weight 12. Like all radioactive elements, carbon 14 decays or disintegrates at a fixed rate; of any given quantity, one-half will have disintegrated at the end of approximately 5,720 years. This is known as the half-life of the element.

Working with this knowledge as background, the three researchers first measured the radioactive carbon content of samples of wood from altitudes ranging from sea level up to the high plateau of Bolivia. The figures for all samples came out fairly uniform, indicating a practically uniform distribution of natural radioactive carbon in the earth's atmosphere.

They next checked their new time-clock by measuring the radioactive carbon content of two

samples of wood from ancient Egyptian tombs whose age was known from other data. The age as indicated by the new method came out very close to the known age. The researchers are continuing the job of "calibrating" their new method, and expect before long to try it on some materials of unknown age.

Canada May Be Leading Producer Of Uranium

TORONTO, March 7—"Canada faces the possibility of becoming the prime source of uranium in the world in the not too distant future," said H. C. Rickaby, Deputy Minister, Ontario Department of Mines.

Mr. Rickaby spoke at the meeting of the Prospectors and Developers Association on "Some Aspects of Ontario Mining".

With particular reference to the Theano Point radioactive discovery, he said that as it was made in granite, many people would have to re-assess their outlook regarding the best place to prospect for radioactive materials.

He pointed out that many of these rocks (granites) are old sediments and volcanics which have been highly altered to gneisses and schists, and that a large area of Ontario was underlain by them.

"No rock showing in our pre-Cambrian areas can therefore be passed over by prospectors as yet in their search for radioactive minerals," he advised the audience.

He promised fast, accurate identification of radioactive minerals by the Assay Office, because it was now equipped with the most modern devices, including laboratory-type Geiger counters and the latest type spectrograph.

"These precision instruments will enable our technical personnel to make a quick determination of samples which are expected in large numbers with the opening of the prospecting season," he said.

Prospecting, the speaker said, had been at a low ebb in recent years because of the gold situation which had been brought about by a great increase in the cost of producing an ounce of gold as well as the return to parity of the Canadian dollar.

"The passing of the Emergency Gold Assistance Act in 1948 is evidence of the concern felt by our Government at Ottawa for the gold industry," he said, pointing out that "this form of assistance is necessarily only of a temporary nature."

Mr. Rickaby thought that because of this fact, the Act did not inspire confidence of risk capital to finance the development or exploration of new gold mines, or of our prospectors to carry on the diligent search for new deposits.

"Discovery of potential new sources of base metals and radioactive minerals all across Canada proves that prospecting is still very much alive and that the desire to find new mines is far from dead," he declared.

These new discoveries, including the oil fields of Alberta as well as the iron ore ranges of Labrador and Quebec, will undoubtedly greatly affect the future economy of our continent, said the speaker.

He referred to the iron ore picture in Ontario and said that the probable iron ore resources of Ontario's known deposits were estimated in the hundreds of millions of tons and that future prospects appear promising. "We can confidently hope to be producing in the near future at least enough ore to satisfy the needs of our own steel industries.

Besides producing 70 percent of

of Canada's steel, Ontario held a decided advantage over other provinces because it was located nearer the great markets for steel. Bituminous coal was comparatively near at hand, yet the province was still seeking ways and means of utilizing Canadian deposits from Alberta and Nova Scotia.

The demand for industrial minerals was great and their production in Ontario had been steadily growing, a trend which he expected would continue. Mr. Rickaby suggested the prospectors should look for new sources of such materials. Eastern Ontario was a logical place to look for these as geological conditions warrant further exploration. A large export market exists for a good number of these products.

Establishment of an air photograph library was going ahead in the East Block at Queen's Park and an announcement would be made as soon as these facilities were available, Mr. Rickaby said. This will be of invaluable assistance to prospectors and mining companies in view of the importance of air photographs in the search for new mines.

Hawaiian Volcano Due For Next Eruption Within Two Years

HONOLULU, March 9 (Science Service)—You can expect another eruption of Hawaii's famed volcano, Mauna Loa, "within two years." That is the forecast of the foremost authority on Mauna Loa, Dr. T. A. Jaggar.

Dr. Jaggar cautions that "within two years" may mean only weeks or months.

If the big mountain, biggest in the world in total volume, keeps up its recent record of eruptions, the next one is due about 1951, however.

The last eruption a couple of months ago was from the summit crater spilling lava southwest. In both 1933 and 1940, there were similar eruptions. Both times, they were followed in two years by summit eruptions which spilled lava toward the northeast.

Thus, the next eruption, if it follows the pattern, will be in about two years, and spill the lava northeast like the 1935 and 1942 eruptions.

Dr. Jaggar, who has had a distinguished scientific career recording the outbursts of the Hawaiian volcanoes, compares Mauna Loa with a giant beer mug.

Some people think that the lava might drain off through underground connections, but it doesn't. That, Dr. Jaggar explains, is "because a froth rises by expanding gases just like beer."

For use in future eruptions, he urges a laboratory which can be used by scientists to make observations of the first hour of an eruption. Dr. Jaggar proposes that a laboratory be built 13,000 feet above sea level on Mauna Loa.

On the less scientific side, he wants a jeep road from Kilauea to Mauna Loa summit house "so that there will be no more lost airplanes, no more pack trains of horses caught in blizzards of sleet and snow and so that science and public can see a Mauna Loa outbreak."

Dr. Jaggar also believes that studies of Mauna Loa and other volcanoes must go down as well as up. 2He would like to see the Navy make a survey of lava flows under the Pacific east, south and northwest of Hawaii Island where Mauna Loa is.

Stone-Age Game Animals Shown In Drawings on Engraved Pebble

CAMBRIDGE, Mass., March 12 (Science Service) — Animals that cave-men hunted in the later Old Stone Age, some 20,000 to 25,000 years ago, are shown in a mass of finely engraved lines on a large rounded pebble, the size and shape of a big potato, found at the La Colombiere rock shelter in eastern France and now at the Peabody Museum of Harvard University. The find was announced today by Dr. Hallam L. Movius, Jr., curator of palaeolithic archaeology.

Similar engraved pebbles have been found in the past, but this is regarded as one of the finest specimens of its kind ever discovered. The drawings, which show such animals as horse, ibex, rhinoceros and bison, are carved one over the other, so that it is somewhat difficult to make out what some of the animals are. One stocky horse figure, however, stands out with particular clearness.

Nobody knows what purpose, if any, these portable art objects served, Dr. Movius states. It is conjectured that they may have had religious or magical significance.

Iron Ore From Venezuela May Help Extend Life of Domestic Ore

NEW YORK, March 15 (Science Service) — Iron ore from Venezuela may soon supplement American ores and extend the life of the fast diminishing domestic supply, the annual report of the United States Steel Corporation, issued today, reveals.

Extensive exploratory drilling in this nearby South American country is in progress in areas believed to contain iron ore deposits of considerable magnitude. U. S. Steel has also taken an option on manganese properties in Brazil and an investigation is underway to determine if they can be economically utilized.

Manganese is an essential in the making of modern steels. An ample supply from South America would relieve the need for Russian ore. Practically one-half the manganese mined in the world is from Soviet territory. Newly discovered manganese deposits relatively near the coast in the Brazilian area north of the Amazon river are closer to the United States than other deposits now used.

Horses Due To Disappear, Evolutionary Curve Shows

ST. LOUIS, March 17 (Science Service)—The horse isn't here to stay. In a relatively short time—geologically speaking — Dobbin will disappear.

Ultimate vanishing date for the horse was set at perhaps 15 or 20 million years hence by Prof. Laurence L. Sloss, Northwestern University geologist, speaking here this morning before the meeting of the American Association of Petroleum Geologists.

Prof. Sloss based his prediction on the known history of horses and horse-like animals. Like all other animals, he said, horses began with a few small species, increased their number as geologic ages passed, and then began to dwindle. By projecting the now descending curve he found it touched the zero line at the 15-to-20 million year mark.

Radio Waves Sent Deep Into Earth Through Sedimentary Formation, Cap Rock and Salt

WASHINGTON, March 20 (Science Service) — Progress in sending radio waves to greater depths in the outer crust of the earth is reported from Texas. Radio waves are stated to have been transmitted through 1125 feet of earth, rock and salt.

In a demonstration by William M. Barrett, geophysicist of Shreveport, La., at the Morton Salt Company's mine at Grand Saline, Texas, new principles and apparatus were used. Radio waves at a frequency of 1602 kilocycles were sent from a portable transmitter located on the earth's surface to a receiver positioned at a depth of about 700 feet within the mine and far removed from any metallic objects.

The transmitter and receiver were separated by approximately 700 feet of sedimentary formations, some 25 feet of cap rock, about 400 feet of salt and 100 feet of air. Elaborate precautions were taken at the surface and underground to prevent any of the radio signals reaching the receiver through air or metal at the mine shaft, which was separated from the receiver by 1,800 feet of circuitous tunnels.

According to Mr. Barret, the method developed by the company of geophysicists of which he is president has possible applications in searching for oil and other minerals. In it, as explained by him, radio waves from the transmitter pass into a unique type of radiating mechanism which directs waves into the earth with far greater effectiveness than heretofore possible with conventional transmitting antennas.

The receiver used in the mine was a conventional type equipped with a radically new type of antenna, which served to collect the wave energy from the transmitter and bring it to the receiver. The radio signals received in the demonstration were heard over a loud speaker while the test was underway, despite the fact that they had travelled through several fresh water sands and some five or nine feet of porous cap rock carrying salt brine.

Considerable research has been carried out during the past decade or so in attempting to send radio waves through earth as an aid to underground explorations. In this, both the U. S. Geological Survey and Bureau of Mines have been active. The latter agency has been particularly interested in saving the lives of miners entrapped underground. With the use of low-frequency waves, it has successfully transmitted the human voice through ground strata alone, and also by way of trolley wires, pipes and other metallic installations.

Map Distribution Center For West Established in Denver

WASHINGTON, March 25 — Director W. E. Wrather announced today that the U. S. Geological Survey has just completed the establishment of a Map Distribution Center in Denver.

Dr. Wrather explained that this Center has been established primarily to bring better service to the people in the western part of the United States. Beginning April 1, 1949, topographic and geologic maps of areas west of the Mississippi River may be obtained by addressing requests to the U. S. Geological Survey, Denver Federal Center Denver, Colorado. Maps of areas east of the Mississippi River should still be ordered from the Director, U. S. Geological Survey, Washington 25, D. C.

Continental Shelf Exploration off Louisiana and Texas

The following is an abstract of the paper "Continental Shelf Exploration off Louisiana and Texas", by Dean A. McGee, which was presented at the Annual Meeting of the American Association of Petroleum Geologists in St. Louis, March 16, 1949:

Discovery of oil in October, 1947, 10½ miles from the Louisiana coast, in the open waters of the Gulf of Mexico, drew the attention of the oil industry to the potentialities of the vast area of the continental shelf off the coasts of Louisiana and Texas. The drilling of this and other wells has shown that the American oil industry can and will devise the methods and equipment needed for the discovery and development of oil in unprotected waters of the continental shelf. The problems and difficulties encountered in exploration, drilling, and production off the Louisiana and Texas coasts have made evident that the economic development of the oil so far found to be discovered will challenge the best that the industry has to offer in methods, men, and equipment.

The continental shelf in the Gulf of Mexico comprises 200,000 square miles. Of this area, 51,000 square miles lie off the Louisiana and Texas coasts. Exploration to date off the Louisiana coast has resulted in the discovery of four oil fields, three gas-condensate fields, and one dry-gas field. No discoveries have so far been made off the Texas coast. Approximately 2 million acres of leases are in force off the Louisiana coast and 2½ million off the Texas coast. A great many salt dome prospects have been found and are under lease off the Louisiana and Texas coasts. Prospects have been mapped that are not yet under lease. Of the known and leased prospects, the most have not yet been tested.

All exploration in the Gulf of Mexico off the Louisiana and Texas coasts has been with geophysical methods. The reflection seismograph has been and is now the principal method used. Many improvements in techniques and methods have been involved for exploratory work on water. At this time the cost per seismic profile obtained is not much greater than the cost on land.

The drilling of wells has been exceedingly expensive but much pioneering has already been done and, although still very costly, the drilling of wells in the ocean waters as far as 26 miles from the coast line is now fairly routine.

The prospects found off the Louisiana and Texas coasts are of the usual Gulf Coast salt-dome types, both piercement and deep-seated domes occurring. The density and pattern of occurrence are similar to those found on the adjacent coastal land areas. All producing zones found to date are probably Miocene in age, ranging from very late through middle and lower Miocene.

Many problems in drilling, producing, and transporting remain to be solved economically, but progress is being made every day and the development of immense reserves of oil and gas in the continental shelf off the Texas and Louisiana coasts is inevitable.

Continental Shelf Petroleum Deposits Investigated

A. C. MONAHAN
Science Service Staff Writer

It takes technical skill, nerve and money to drill an oil well out in the sea far from the mainland to tap the oil in the ocean bed. But the underwater land may soon become America's principal source of crude oil for fuels, gasoline and the thousands of products obtained from petroleum.

Much Experience

The American oil industry, backed by years of experience in obtaining underwater oil off the coasts of California, Texas, Louisiana and Venezuela, has gone far out in the Gulf of Mexico and now has several producing wells. The so-called continental shelf of this great gulf promises to become a great oil field.

The industry is not waiting a final federal determination to the political question of the ownership of the oil. It will pay its share of the production to the federal government or to the individual state when the determination is made. In the meantime, it realizes that demands for petroleum products is on the increase and known land reserves are facing exhaustion. It is going ahead on a program of getting oil from wherever it can be obtained.

Drilling through water for oil in the earth under it is nothing new. Thousands of producing wells are in operation off Western and Gulf coasts, and along the Caribbean shore. The drilling and the maintenance cost more than for wells on dry land. The process presents no very great difficulties where the water is shallow enough to permit the construction of drilling platforms, and where the shore may be used for crews, equipment and supplies.

Out to Sea

Drilling miles from the shoreline is a different matter. The out-to-sea drilling already underway is in relatively shallow waters where working platforms on high stilts can be erected. These platforms have got to be large to accommodate all the machinery, power plants, fuels and accessories necessary, and they have got to be high above normal sea level for safety in storms.

Operations in open water encounter the problems of the elements, as well as those encountered on land. In the Gulf area, they include tidal waves and hurricanes. Auxiliary operations, such as transportation and drilling site preparation are major items from both technical and financial viewpoints.

Gulf Reserves

The principal interest at the present time in the recovery of oil from underwater sands is in the Gulf of Mexico because oil men believe that they will find the best oil reserves there. Explorations, however, are being made in other regions. Notable among these are the activities for petroleum possibilities in relatively shallow waters near the Bahama Islands.

Some two years ago, the U. S. Geological Survey and the U. S. Navy in cooperation undertook a scientific exploration of the con-

tinent shelf in the Gulf of Mexico. Possible oil formation was only one objective. The undertaking included a gravimetric survey, a system long used to determine hidden geological formations, to get an insight into the structure of the shelf. It revealed the presence of structures believed to be salt domes. These have the same gravimetric characteristics as oil bearing salt domes found on land. Whether or not these contain oil can be determined only by drilling.

Wells in Production

The area in which these domes was found is some 50 miles in width and extends about 70 miles out in the Gulf. It is in this general region that two productive wells have already been drilled. One is a very shallow well according to today's well depths, being about 1,750 feet deep, and producing from a supercap of sand. It was installed by Kerr-McGee Oil Industries, and is off Terrebonne Parish, Louisiana.

A second producting well, off Jefferson Parish, La., is a project of the Humble Oil and Refining Company. It is the result of a second try on the part of the company, the first not being a success. Additional wells will be required, officials of the company state, before the real value of the discovery is known. But, they say, the prospects are promising.

The continental shelves of the world are the submerged extensions of the continents and islands that extend from a few to a few hundred miles off shore. As generally understood, a continental shelf is the land lying submerged off continental coasts in less than some 600 feet of water. At its outer edge, it breaks more or less abruptly, with ocean bed beyond at a much greater depth.

The continental shelf of the United States is estimated to cover some 750,000 square miles, of which 129,000 are in the Gulf of Mexico. The Atlantic American shelf extends from the Newfoundland banks to the West Indies, and the Pacific shelf along the entire west coast. There is a new interest awaking in regard to them because of their possible oil deposits, but they have always been important for commercial fishing. Fish life is most abundant over the continental shelves because it is in these relatively shallow waters that the fish find food.

No one really knows how much oil there is in the continental shelves of the world, or even those in the Gulf of Mexico. One of America's leading petroleum geologists hazarded an estimate recently that there are 1,000,000,000,000 barrels in the world's shelves, and another an estimate of 15,000,000,000 barrels in the shelf of the Gulf of Mexico. How to find the oil, and how to get it out, are the important questions.

Scientists of the world have already determined the so-called petroliferous regions, or areas with a proper geological history, to be favorable for the formation of petroleum. Magnetic surveys, made with the magnetometer trailing behind and under an airplane, have already been made in the Bahama region. Such surveys have been found helpful in locating hidden geological structures that may contain oil.

Bahamas

The so-called gravity method of studying hidden structure was also used in the Bahama explorations. In this case, instruments and operators were lowered under giant diving bells to the floor of the ocean. The so-called seismic

method, the most commonly used scheme for locating hidden oil in land explorations may some day be adapted for underwater determinations. Like others, it supplies information about the structure of the crust of the earth. Oil is proven only by drilling, except in the few places it has been found seeping from the surface.

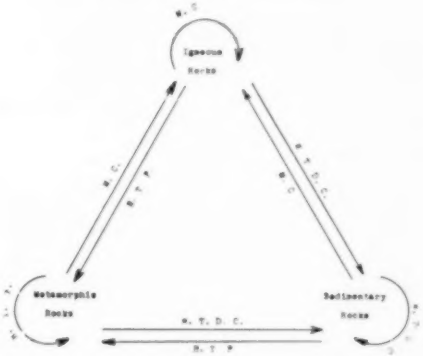
For drilling in shallow waters, the platform plan, now in use in the Gulf, is satisfactory although hazardous and costly. Another plan, proposed by a scientist, involves the use of giant diving bells anchored to the ocean bed, and large enough to house a derrick and drilling rig.

Then there is the proposal to tunnel out from the mainland, with an enlargement of the tunnel at the outer end to house the drilling equipment.

Still another scheme would utilize large anchored platforms of the type once proposed to use for mid-Atlantic landing fields for planes. Some of these methods may sound impractical, but it may be safely assumed that a way to recover part at least of the continental shelf oil will be found if the demand becomes great enough to warrant the cost.

The Rock Cycle

W. D. KELLER
University of Missouri



W. T. D. C. — Weathering, Transportation, Disposition, Diagenesis, and Consolidation.

H. T. P. — High Temperature and Pressure.

M. C. — Melting (Solution) and Cooling (Solidification).

"A single drawing may tell more than a thousand words" may well paraphrase the familiar Chinese proverb. The single graphical illustration of the rock cycle summarizes at a glance what took columns to explain in words (*The Earth Science Digest*, November, 1947). It covers the essence of the relationship between three of the dominant processes of geology: Vulcanism, Gradation, and Metamorphism. And they constitute a goodly portion of the subject matter in introductory physical geology. The writer has utilized this illustration to teach the rock cycle in geology classes for over twenty years with excellent response.

The rock cycle shows that geologists will never run short of rocks: igneous to sedimentary to metamorphic, or sediments and metamorphics "granitized" to igneous types, or sediments and metamorphics altered to new bodies of the same—they are all part of the big cycle. Geology abounds in cycles: for example, the cycle of erosion, the phosphorus cycle, the meteoric water cycle, etc., and not the least of these is the rock cycle

Field Geology At Camp Branson

ROGER L. SPITZNAS
University of Missouri

R. F. Littlefield

A field party identifying and making notes on fossils recovered from lower Paleozoic formations in Sinks Canyon.

Again this summer nearly five hundred students of geology from campuses throughout the United States will attend a dozen or more geology field camps operated by the country's colleges and universities. For many of the students attending these camps this will be their first experience with field geology in its many ramifications. Such practical field experience is essential in the training of all geologists, and as an expression of its firm belief in the vital role of field training, the Department of Geology, University of Missouri, is this summer offering its 40th annual summer field session in geology at Camp Edwin Bayer Branson* in the Wind River Mountains near Lander, Wyoming.

The history of Camp Branson has been the story of forty years of work and energy on the part of its founder, Dr. E. B. Branson. Since its founding the camp has seen an ever expanding development and more widespread recognition. The physical development of the camp has been from a temporary tented camp to the present with permanent buildings used as dormitories, laboratories, and mess hall. The Age of Lamps has passed at camp, and it is lighted with electricity from the town of Lander, twelve miles away.

Early in the second week of June each year the field party departs from the University at Columbia, Missouri, for an eight week study of geology as it is pre-

* The camp was formerly known as Camp Lander, but in 1947 it was renamed to honor its founder, Dr. Branson, upon his appointment as professor emeritus.

sented by Nature herself. The 1,200 mile trip from Columbia to Lander, Wyoming, is used as a period of study of the many geologic features enroute to camp. Most notable of the stops made are visits to salt mines in Kansas, study of the Niobrara chalk deposits, and concentrated study of the Front Range region near Boulder, Colorado.

After five days of travel and study the party arrives at camp on the flank of the Wind River Mountains twelve miles from Lander. Advance parties have the camp in full operation, and little time is lost before actual field work begins. Systematic geologic mapping and reporting follows reconnaissance work in the stratigraphy of the Paleozoic, Mesozoic, and Cenozoic sedimentary formations as they are exposed in various structural features within the region. Mapping, including that done on two producing oil domes, is done by use of the Brunton compass and hand-level or telescopic alidade depending upon the course in which the student is registered. Varied structural forms are available for study and interpretation by the students, and never does a student return to the classroom without a better understanding of structural mechanics and forms.

R. F. Littlefield

Field instruction includes work with the telescopic alidade as shown by this field party.

Igneous areas close to camp offer plentiful opportunity for work in igneous petrography and interpretation of the importance and order of igneous activity both in the Wind River batholith and beyond.

Roger L. Spitznas

The laboratory building where many hours are spent transferring field data to maps and reports of the assigned projects.

A metamorphic area near Atlantic City, Wyoming, affords instruction in metamorphic geology through mapping, description, and interpretation. With this study the coverage of the three main rock types is complete.

Projects in economic geology include the mapping and study of the Dallas and Hudson Domes, both of which are oil producing; gold deposits near South Pass City are viewed, and a study of Cretaceous coals is made near Lander.

As a further part of the field experience students are conducted on a four-day geologic trip to the Thermopolis hot springs, Yellowstone National Park, and the Grand Tetons. This trip often gives the student his first view of these areas, and the geologic interpreta-

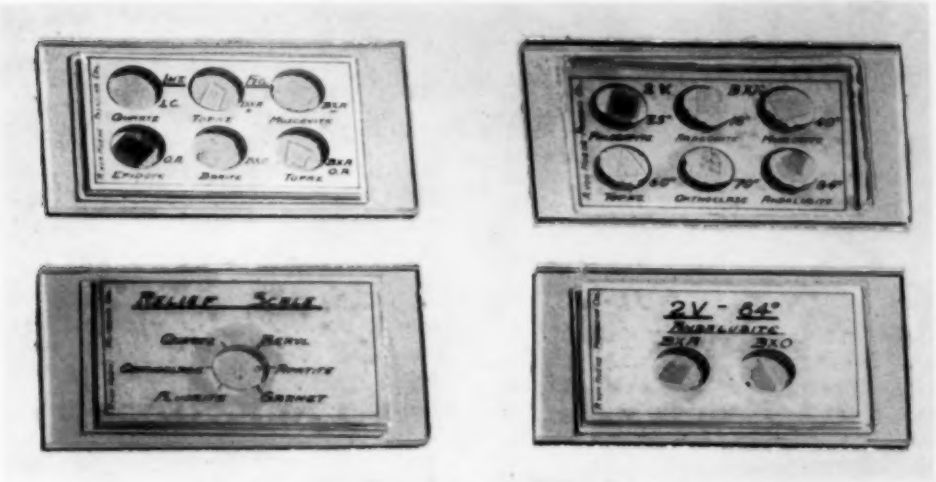
tion of each enriches the student's understanding of the areas.

Near the end of the season everyone is given the opportunity to make a three-day pack trip into the heart of the Wind Rivers to climb Wind River Peak. The party hikes twelve miles into the wilderness area where base camp is established at Bill's Lake, and horses carry all provisions and bedding. The second day is used to make the 14 mile roundtrip to the peak 13,200 feet above sea level. Many evidences of valley glaciation such as cirques, tarn lakes, and glacial valleys are seen during the trip to the top. This venture is indeed a highlight in the eight week trip, and seldom is anyone sorry for his expended energy used to make the trip.

During weekends everything is not work, and the students and faculty take advantage of the free hours for riding, fishing, baseball, and a visit to town which enlivens each weekend. Holidays bring work-free hours which are spent in attendance at the Lander Pioneer Days, 4th of July, parade and rodeo combined with picnics at the lakes high above camp. At these picnics singing and tale telling around the fire are enriched by tales told by Sid Winship, a friend and summer neighbor of the camp.

After eight weeks of geologic field training camp disbands, and everyone returns to the campus with knowledge and experience that is obtainable only by meeting geology in the field.

New Teaching Aids in Optical Mineralogy



Multiple Oriented Sections. Interference figures: quartz perpendicular to C (uniaxial positive); topaz, perpendicular to Bxa (positive); muscovite, perpendicular to Bxa (negative); epidote, optic axis; barite, perpendicular to Bxo; topaz, halfway between optic axis and Bxa. 2V Slide: phlogopite 7.5 degrees, aragonite 18 degrees, muscovite 40 degrees, topaz 60 degrees, orthoclase 70 degrees, andalusite 84 degrees (all plates perpendicular to Bxa). Relief Scale: fluorite, orthoclase, quartz, beryl, apatite, and garnet. Bxa—Bxo slide: A plate of andalusite (84 degrees).

A new method has been developed by Dr. Rudolf Von Huene, California Institute of Technology, for making grain-thin sections so that all of the optical characteristics of a mineral can be studied without the usual difficulty in locating properly oriented specimens. Grains of one mineral, crushed to between 9 and 60 mesh, are mounted at random orientation and are ground to standard thickness. The individual grains are completely surrounded by Canada balsam or preferably Lakeside No. 70 transparent cement and are mounted on standard sized petrographic slides*.

Multiple oriented sections have been made for studying the different interference figures, the appearance of the isogyres for different values of 2V, the relief scale, and the difference in appearance between the Bx_a and the Bx_o for large optic axis angles.

A more detailed discussion by Dr. Von Huene may be found in the January–February 1949 issue of *The American Mineralogist.*

***Forty different mineral grain-thin sections and the set of four special slides are obtainable through Ward's Natural Science Establishment, Rochester, N. Y., or through Dr. Von Huene.**

Tiny Diamonds Help Make Big Dams Safe

Tiny diamonds in the skillful hands of core drillers such as the United States Bureau of Reclamation's E. D. "Dusty" Rhoades, help tell engineers where they can safely build big dams to harness the country's rivers. Rhoades is the diamond driller who received a $1000 prize on March 16 for inventing a device that engineers think will cut huge sums from drilling costs in dam construction.

Since the structure of the rock and the character of the underground streams below must be known before a dam can be built, deep holes must be sunk at dozens and sometimes scores of places over a site. Diamonds commonly point the drills that sink these holes and carve out sample columns of the rock, an operation that costs from around $1,500 and upward for each hole drilled.

Because it will enable one such hole to do the work of six or eight which otherwise would have to be sunk at each place where underground water tables must be tested, the little steel and rubber "multi-packer" invented by Rhoades can run up phenomenal savings in the cost of dam construction, Reclamation engineers say.

Underground water tables are frequently found at various levels at a given location, and the character of each stream within a range of several hundred feet down must be explored in choosing a dam and reservoir site. The engineers must not only know whether or not the rock will hold up the tremendous weights of big dams, but whether these underground streams will undermine foundations or cause the water to leak out of the reservoir, sometimes with damaging results to areas further down the river.

With the practical experience of drilling holes aggregating over 100 miles in total depth over the past 30 years, "Dusty" Rhoades found that it was not necessary to drill a separate hole to test each particular stream strata at a given place. So, with steel, rubber, and lengths of copper pipe, he fashioned a device that would seal off each separate stream in a single test hole, and let its depth and flow be measured via a long copper tube running up to the surface.

Reclamation engineers estimate the savings from use of the "multi-packer" will run several hundred thousand dollars on the Columbia Basin project's North and South Dams and O'Sullivan Dam, alone. Its use on other dams now scheduled for construction is expected to save over $1,000,000; and over the future Reclamation program engineers think the savings will run into the $10,000,000 bracket.

Also substantial savings are seen as possible in ascertaining the depths at which the best underground water sources to be tapped for wells all over the United States.

Application for a patent is being made by the Department of the Interior in the name of the United States Government.

Core drilling has become a legendary art which commonly attracts colorful men. The heart of the operation is the diamond-toothed bit, which, attached to long steel pipes, and with power supplied by a special rig, will eat its way through the hardest rock. Even the toughest steel bits quickly dull, whereas the dia-

monds, the hardest natural substance known to man, keep on pulverizing the rock long after a steel bit would have become useless. While cheaper synthetic substitutes for diamonds are now growing in popularity, many drillers, particularly the old timers, still prefer actual diamonds. The diamonds are set, with a jeweler's care, in the drill bit, a section of soft steel not unlike the end of a piece of gas or water pipe. The diamonds, ranging from the size of a pinhead to a pea are carefully wedged by hand into notches cut in the soft steel.

Depending upon the information desired and the indicated size of the hole to be drilled, the bits range from five-eighths of an inch upward to several inches in diameter, and the holes are often sunk from 200 to 300 feet deep. A single bit may have dozens, and sometimes scores of diamonds encrusted upon it.

Sometimes valuable diamonds come loose from the drill bit and are lost in a hole far down in the bedrock. Then begins an operation not unlike a small boy tipping the end of a stick with a bit of chewing gum to recover a shiny dime from between the cracks in a board walk. A special bit, encrusted with wax, is lowered and the hole is probed until the diamond sticks in the wax and is pulled to the surface.

Stories are common in construction circles on the loss and recovery of valuable diamond bits. One most often repeated is of a bit worth $10,000 which was lost in the Colorado River in the 1920's during explorations preliminary to construction of Hoover Dam, the world's highest. This bit was not lost underground, but simply rolled off a barge containing the drilling equipment.

The survey party quickly plotted the location on a chart by means of a surveyor's transit. A long time later, when the diversion tunnels were completed and the dam site cleared of water, workmen used the chart to recover the diamond-studded bit.

The larger diamonds aren't the same kind found in rings and other jewelry. They are black diamonds, or carbonados, mined from the gravel beds of the interior of Brazil. They are dull and lustreless, looking not unlike shiny black lumps of their cousin, coal. Another type is bortz, which is similar to the gem but is not used for jewelry because of poor color or other imperfections.

When new diamonds are needed, Reclamation advertises and a large quantity is forwarded by the importers to a purchasing office where a diamond specialist, frequently the driller himself, selects the best stones from unmarked boxes without knowing the supplier. The contracting officer buys the stones selected.

QUATERNARY RESEARCH CONFERENCE TO BE HELD IN HUNGARY

The Fourth International conference on Quaternary Research will be held at Budapest, Hungary, from August 22 to September 15, 1949. Students in all phases of Pleistocene research — anthropology, geomorphology, paleontology, and stratigraphy—are cordially invited to attend. Two excursions, each about one week long, will be conducted to Eastern and Western Hungary.

Those planning to attend are requested to contact the Hungarian Committee for INQU IV, Hungarian Geological Institute, XIV Vorosilov-ut 14, Budapest, Hungary.

New Books

COLLEGE GEOGRAPHY — third edition revised by Earl C. Case. 1949. 790 pp., 295 figs.; $5.00. (John Wiley & Sons, Inc., New York). The third edition of this book by Earl C.. Case and Daniel R. Bergsmark has been brought up to date with an expansion on those areas that have recently become of increasing importance to the United States: the Pacific islands, Russia, western Europe (especially the Ruhr), and the borderlands of the Arctic Ocean. A new chapter, "Tropical and Semi-Tropical Islands of the Pacific", has been added, with emphasis on "The United States in the Pacific".

A section on minerals and mineral industries presents an excellent treatment of the iron and steel, coal, petroleum, and copper industries. Also discussed are lead, zinc, aluminum, tin, manganese, nickel, gold, silver, natural gas, building materials, and water power.

This text fully meets the needs for a basic course emphasizing regional and economic geography. All the charts, graphs, and subject matter have been brought up to date, and the new physiographic diagrams and distribution maps tend to bring a more basic understanding of the subject matter to the reader.

HANBOOK OF URANIUM MINERALS — by Jack DeMent and H. C. Dake. 2nd Edition. 1948. 96 pp., 22 illus.; $2.00. (Mineralogist Publishing Company, Portland, Oregon). In the light of present day interest in the uranium minerals and uranium prospecting, the authors have prepared an up to date edition of this interesting little book. The chapter of world occurrences of uranium has been considerably enlarged. The story of the discovery of the Great Bear Lakes deposits by Gilbert La Bine is added, and the text of the United States Atomic Energy Commission Circulars Nos. 1 and 2 are printed in whole. The appearance of the book has been improved, and the number of typographical errors has been considerably reduced.

PERMIAN CRINOID CALCEOLISPONGIA (Memoir 34, The Geological Society of America)—by Curt Teichert. 1949. 132 pp., 26 pls., 24 figs.; $2.50. CALCEOLISPONGIA is a peculiar crinoid found in the Permian faunas of Western Australia. They make excellent index fossils for most of the 13 species described are short-lived and seldom more than two are found in the same horizon. Its main characteristics are the greatly enlarged basal plates, which become almost indestructible through the metasomatic replacement of the calcite by limonite and turgite. Gigantism and spinescence were the main evolutionary trends in CALCEOLISPONGIA. During the course of its evolution, a period of about 6,000,000 years in length, the basal plates increased in bulk 40,000 per cent. Twenty-five excellent plates of specimens, mainly basal plates, are included in this work.

PRINCIPLES OF PETROLEUM GEOLOGY — by Cecil G. Lalicker. 1949. 377 pp., 8 pls., 157 figs.; $5.00. (Appleton-Century-Crofts, Inc., New York). For the first time, in a text of this kind, the stratigraphic and geographic distribution of petroleum is described in detail. The oil and gas fields described are logically grouped according to the type or origin of structure. Over sixty tables of stratigraphic sections in oil and gas fields are included in the text. The author

lays stress upon the mode of origin of oil and gas structures and the methods of petroleum discovery. Separate chapters are devoted to geological considerations in recovery methods and the valuation of oil and gas properties. The text is clear and concise and should offer very little difficulty to the student.

The author states in the preface that "exceptional progress has been made by geologists and other scientists in petroleum discovery methods during the past twenty-five years, even though it has become increasingly more difficult each year to find new reserves. Great advances have also been made in solving some of the more important problems of petroleum geology, such as the nature of source beds of petroleum, biochemical and geochemical changes in source materials, migration of petroleum, and origin and classification of oil and gas reservoirs. Continued active cooperation of geologists, engineers, chemists, physicists, and biologists is necessary to completely solve these problems."

GEOLOGY AND ORE DEPOSITS OF BOISE BASIN, IDAHO (Bulletin 944-C, U. S. Geological Survey) — by A. L. Anderson. 1947 (1949). 214 pp., 40 pls., 2 figs.; $2.25 (Sold by Superintendent of Documents, Govt. Printing Office, Washington 25, D. C.). Boise Basin, famed for its rich placer deposits, is an area of approximately 300 square miles in southwestern Idaho. It is underlain chiefly by the granite rock of the Idaho batholith, of Mesozoic age, which is cut locally by dikes and stocks of early tertiary (?) and lower Miocene age. The general and historical geology, the character and distribution of the ore deposits (precious metals, particularly gold, and small amounts of base metals), the characteristic composition of the ore, and detailed description of over 80 mines and prospects are included in the report.

CHEMICAL AND PETROGRAPHIC STUDIES OF THE FORT HAYS CHALK IN KANSAS (Bulletin 82, Part 1, State Geological Survey of Kansas, Lawrence, Kansas) — by Russell T. Runnels and Ira M. Dubins. 1949. 36 pp., 6 figs.; $0.10. The chemical composition, petrographic character, and commercial usefulness of the Fort Hays Chalk are described. It is the lower member of the Cretaceous Niobrara formation and outcrops occur extensively in north-central and central western Kansas.

ADDITIONAL ANALYSES OF COALS OF OHIO (Report of Investigations No. 4, Geological Survey of Ohio, Columbus 10, Ohio) — compiled by Ethel S. Dean. 1948. 17 pp., 1 fig.; free. An additional fifteen coal samples were analyzed by D. J. Demorest to add to the original work published in 1929 (Analyses of Coals of Ohio — by J. A. Bownocker and Ethel S. Dean. Bulletin 34, 360 pp.; $1.00).

GEOLOGY OF THE SOUTHERN GUADALUPE MOUNTAINS, TEXAS (Professional Paper 215, U. S. Geological Survey) — by P. B. King. 1948 (1949). 189 pp., 25 pls., 24 figs.; $3.25 (Sold by Superintendent of Documents, Govt. Printing Office, Washington 25, D. C.). This report describes the stratigraphy, structural geology, and geomorphology of an area of 425 square miles that includes the southern end of that part of the Guadalupe Mountains lying in Texas. The plates accompanying the report include colored maps that illustrate the areal geology, geologic structure, and Cenezoic deposits and land forms of the area; panoramic drawings that show the geologic features to be seen on the escarpments and canyon walls of the mountains; and sheets of plotted stratigraphic sections that were measured in the area.. The consolidated rocks are all marine sediments of Permian age.

BARITE DEPOSITS OF CAMAMU BAY, STATE OF BAHIA, BRAZIL (Bulletin 960-A, U. S. Geological Survey)— by A. J. Bodenlos. 1949 (1949). 37 pp., 8 pls., 3 figs.; $0.75 (Sold by Superintendent of Documents, Govt. Printing Office, Washington 25, D. C.). Large barite deposits, developed for mining during the years 1941-46, occur in a sedimentary sequence of Cretaceous rocks. Because of the large reserves in sight and because the barite is favorably situated for low-cost production, the deposits promise to become a major South American producer. The report covers the distribution, grade, and reserves of the barite, as well as the geology necessary for the calculation of these data.

TIN-BEARING PLACERS NEAR GUADALCAZAR STATE OF SAN LUIS POTOSI, MEXICO (Bulletin 960-D, U. S. Geological Survey) — by Carl Fries, Jr., and Eduardo Schmitter. 1948 (1949). 45 pp., 6 pls., 1 fig.; $0.50 (Sold by Superintendent of Documents, Govt. Printing Office, Washington 25, D. C.).. Large placers containing tin (cassiterite), mercury (cinnabar), and minor quantities of silver and gold are found near Guadalcazar in the central part of the State of San Luis Potosi. The bedrock consists mainly of Cretaceous limestone and shale that has been intruded by a small stock of porphyritic granite surrounded by a limestone upland deeply dissected by steep-sided arroyos and characterized by numerous sinks.

The BOOK SHELF

All books listed here may be obtained by sending a check or money order to the BOOK SHELF, THE EARTH SCIENCE PUBLISHING COMPANY, REVERE, MASS. We pay postage.

MINERALOGY

DANA'S SYSTEM OF MINERALOGY by Palache, Berman, and Frondel
Vol. 1—Elements, Sulfides, Sulfosalts, Oxides (1944) **$10.00**
DESCRIPTIVE LIST OF THE NEW MINERALS — 1892 - 1938 by English (1939) ..... **$ 3.50**
ELEMENTS OF MINERALOGY by Winchell (1942) ..... **$ 5.65**
ELEMENTS OF OPTICAL MINERALOGY by Winchell:
Part 1—Principles and Methods (1937) ..... **$ 4.25**
Part 2—Description of Minerals (1933) ..... **$ 6.50**
Part 3—Determinative Tables (1929) ..... **$ 6.00**
GETTING ACQUAINTED WITH MINERALS by English (1936) .... **$ 2.75**
HANDBOOK OF URANIUM MINERALS by DeMent and Dake (1948) ..... **$ 2.00**
INTRODUCTION TO THE STUDY OF MINERALS by Rogers (1937) **$ 5.50**
MANUAL OF DETERMINATIVE MINERALOGY WITH TABLES by Lewis. Revised by Hawkins (1931) ..... **$ 3.50**
MANUAL OF MINERALOGY by Dana. Revised by Hurlbut (1941) .. **$ 4.50**
MINERAL COLLECTOR'S HANDBOOK by Pearl (1947) ..... **$ 3.75**
MINERALOGY by Kraus, Hunt, and Ramsdell (1936) ..... **$ 5.50**
MINERALS AND HOW TO STUDY THEM by Hurlbut (1949) ..... **$ 3.90**
OPTICAL CRYSTALLOGRAPHY by Wahlstrom (1943) ..... **$ 3.25**
OPTICAL MINERALOGY by Rogers and Kerr (1942) ..... **$ 4.00**
QUARTZ FAMILY MINERALS by Dake, Fleener, and Wilson (1938) **$ 2.75**
TABLES FOR THE DETERMINATION OF MINERALS by Kraus and Hunt (1930) ..... **$ 3.25**
TEXTBOOK OF MINERALOGY by Dana. Revised by Ford (1932) .. **$ 6.00**
THE BOOK OF MINERALS by Hawkins (1935) ..... **$ 1.75**
X-RAY CRYSTALLOGRAPHY by Buerger (1942) ..... **$ 7.50**

PETROLOGY; PETROGRAPHY; etc.

IGNEOUS MINERALS AND ROCKS by Wahlstrom (1947) ..... **$ 5.50**
IGNEOUS ROCKS AND THE DEPTHS OF THE EARTH by Daly (1933) ..... **$ 6.00**
METHODS OF STUDY OF SEDIMENTS by Twenhofel and Tyler (1941) ..... **$ 2.25**
PETROGRAPHY AND PETROLOGY by Grout (1932) ..... **$ 5.50**
PRINCIPLES OF SEDIMENTATION by Twenhofel (1939) ..... **$ 6.00**
ROCKS AND ROCK MINERALS by Pirsson and Knopf (1947) ..... **$ 4.00**
SEDIMENTARY ROCKS by Pettijohn (1949) ..... **$ 7.50**

A complete catalog of books on the earth sciences is now in preparation. Please watch for further announcements in The Earth Science Digest.

MALACHITE from THREE CONTINENTS

A short time ago we had an opportunity to secure an accumulation of MALACHITE that was originally from a lapidary who imported cutting material that met rigid specifications. The material had been purchased from Russian, South African, and American sources prior to 1915. The lot consisted only of cutting material of highest quality and it is a pleasure to offer this MALACHITE in specimens that every collector will be proud to own and exhibit.

RUSSIAN MALACHITE

MALACHITE from Russian mines has been used for a great number of years for ornamental purposes since it has beautiful round bandings and various shades of green color. Polished slabs at 1½"x2" $2.00; 2"x2" $2.50; 2"x3" $3.00; 2½"x3½" $4.00; 3"x4" $5.00, $6.00 and $7.50 each.

Chunky pieces in the rough are available for carving, inlay work, sphere cutting or gem cutting. Pieces will average approximately from two pounds to five pounds each at $6.00 per pound.

RHODESIAN MALACHITE

MALACHITE from South Africa is also prized for its compactness, beautiful bandings and is easy to work. Specimens we offer are mostly of straight bandings. 1½"x2" $1.50; 1½"x2½" $2.00; 1½"x3" $2.50; 1½"x3½" $3.00; 1½"x4" $3.50.

This is also available in unpolished slabs 1½"x2" to 1½x4" and 5/16" thick at 35c per square inch. Minimum order $2.00.

ARIZONA MALACHITE

MALACHITE from Arizona that is suitable for polishing is comparable to the finest Russian MALACHITE but of slightly darker shades of green. Selected polished specimens of rich color and bandings polished on rounded surfaces 1"x1½" $1.00; 1"x2" $1.50; 2"x2" $2.00; 2"x3" $2.50 and $3.00; larger pieces at $5.00 and $7.50 each.

Postage and insurance charges are additional.

Any overpayment will be returned at once.

SCHORTMANN'S MINERALS

10 McKINLEY AVENUE **EASTHAMPTON, MASS.**